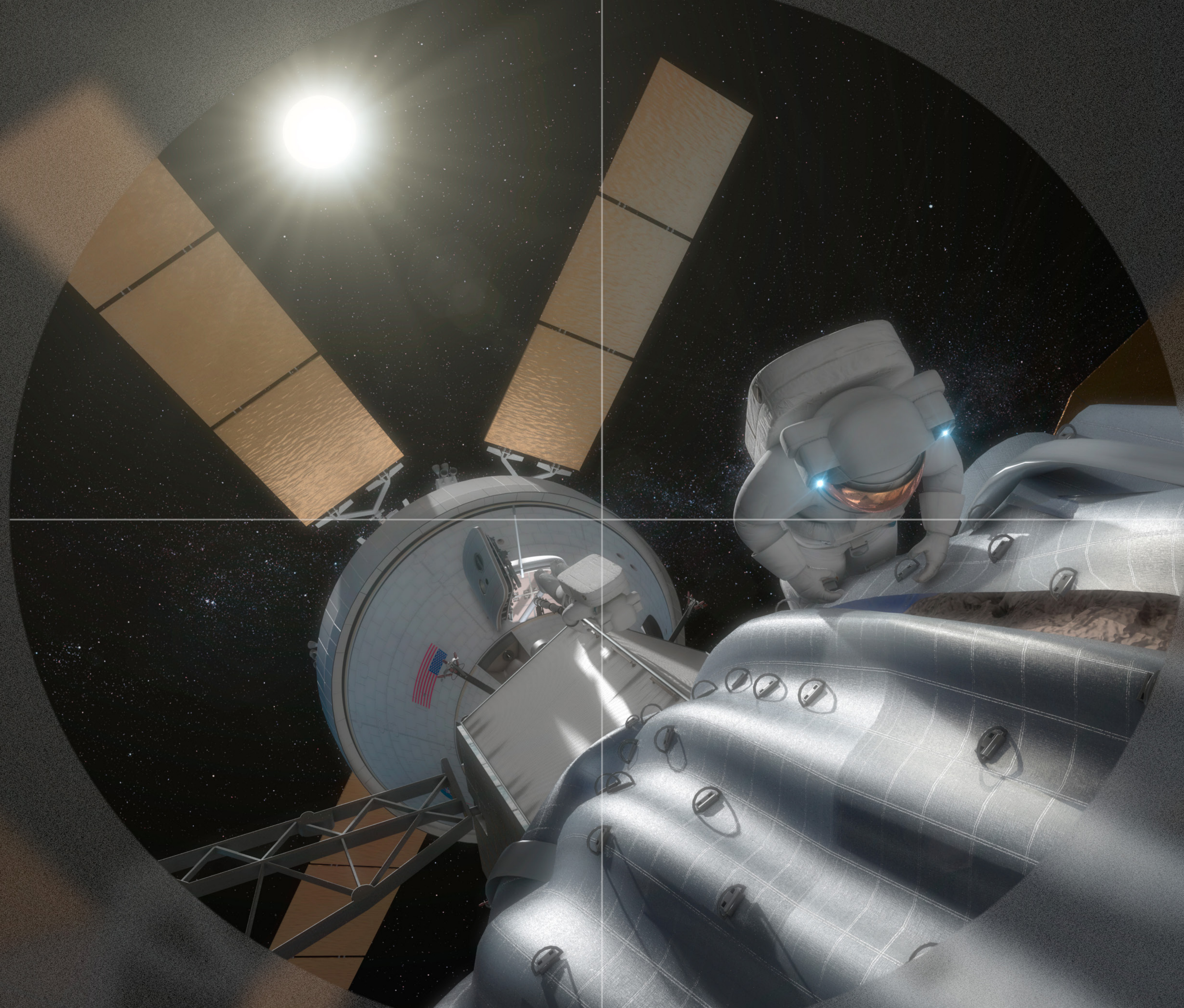
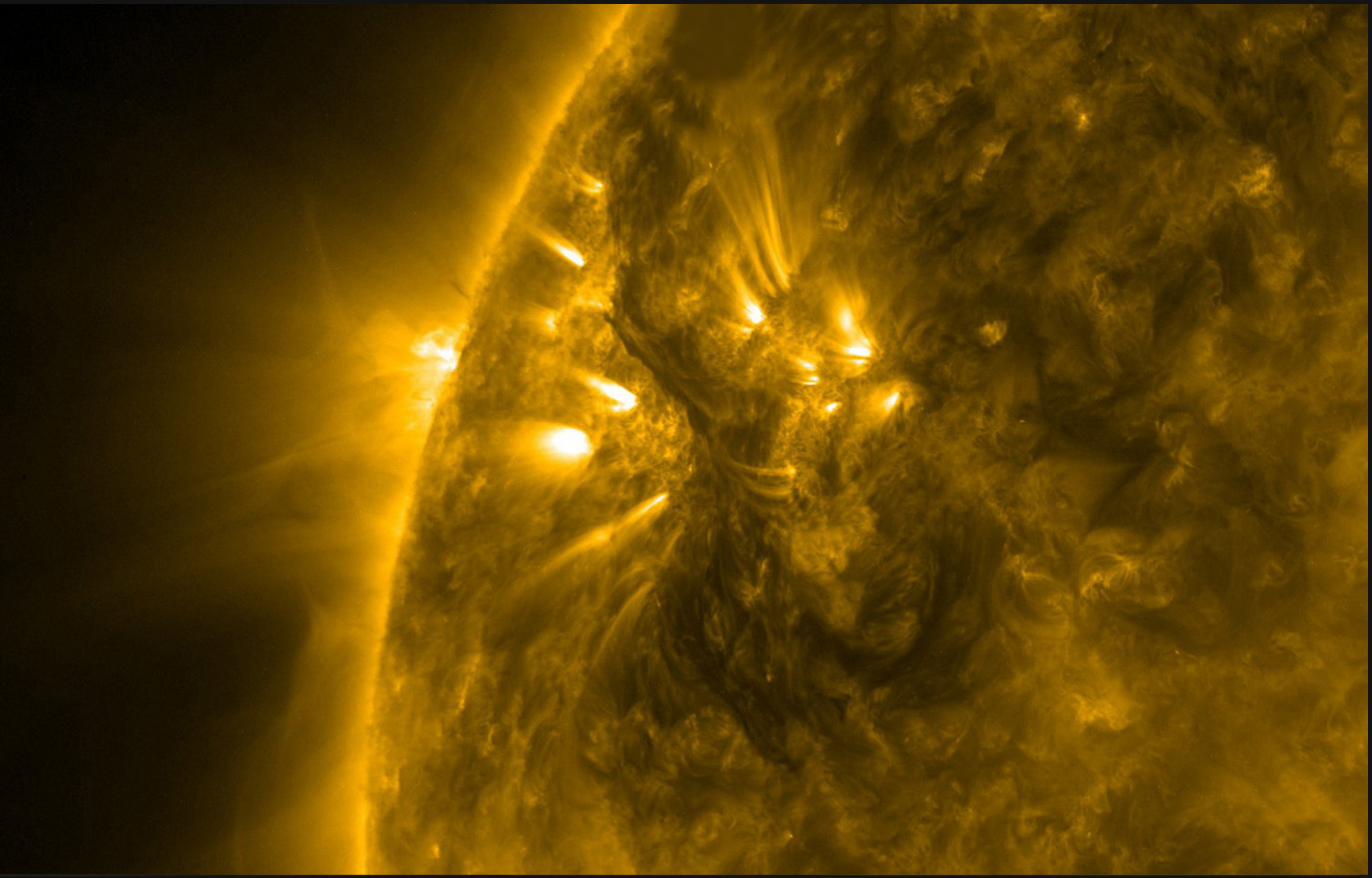
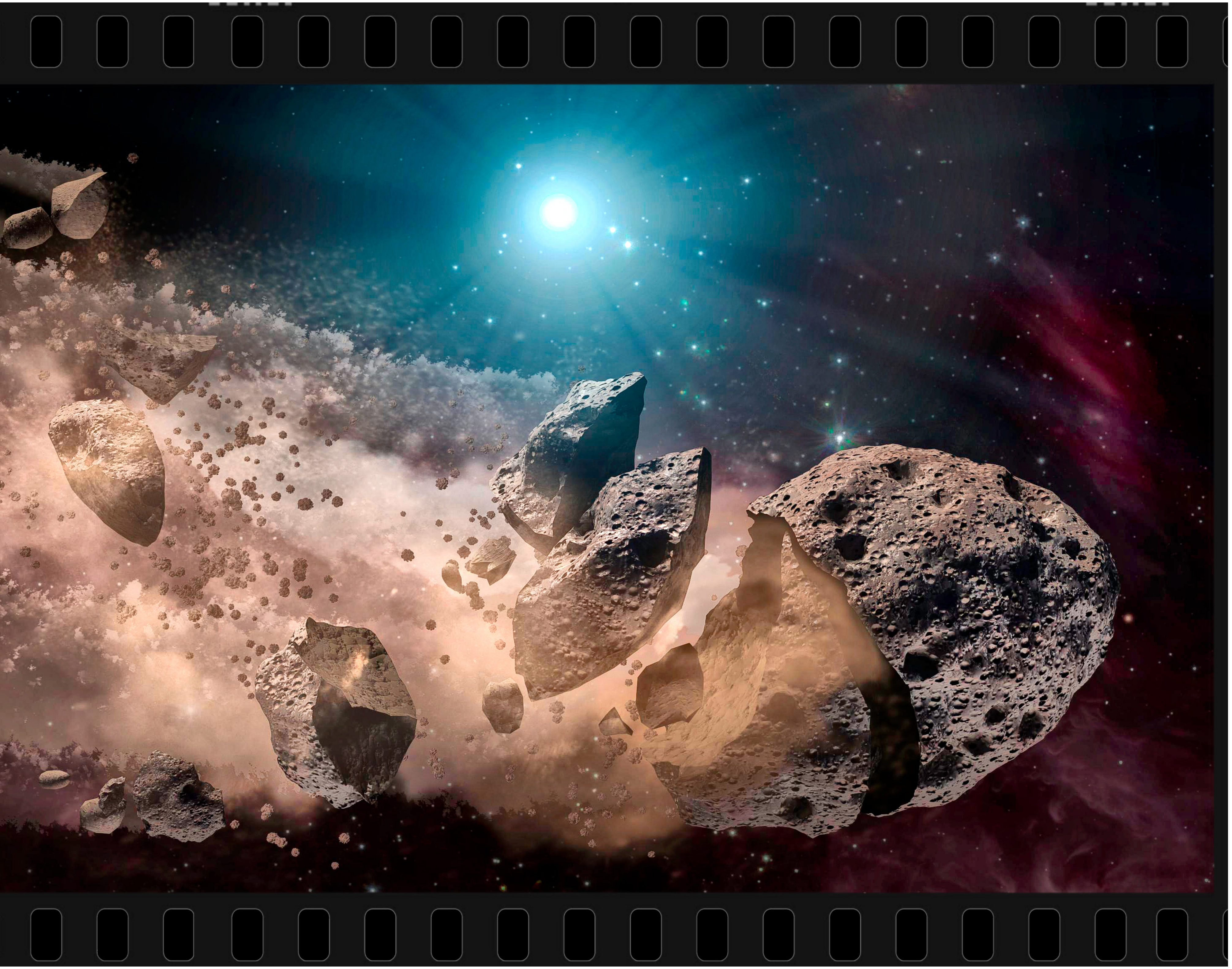
National Aeronautics and Space Administration

2013 SBIR/STTR Annual Report



As America embraces the changes of our world today, technological innovation remains vital to strengthening the Nation's competitiveness and job growth as well as performing NASA's mission. Through the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs, small business concerns and research institutions develop pioneering technologies that transition not only into NASA missions, but also into commercially available products and services for the Nation. These programs spur entrepreneurship while providing opportunities for Americans to contribute to the Nation's effort to innovate and thrive in the global economy.





Financials & Awards

The mission of the SBIR and STTR programs is to support scientific excellence and technological innovation through the investment of Federal research funds in critical American priorities to build a strong national economy. Each year, 2.5% of NASA's budget goes towards SBIR awards, and 0.3% towards STTR awards. Historically, the percentage of Phase I proposals to awards is approximately 13-15% for SBIR and STTR, and approximately 35-40% of the selected Phase I contracts are competitively selected for Phase II follow-on efforts.

Key Statistics by Program

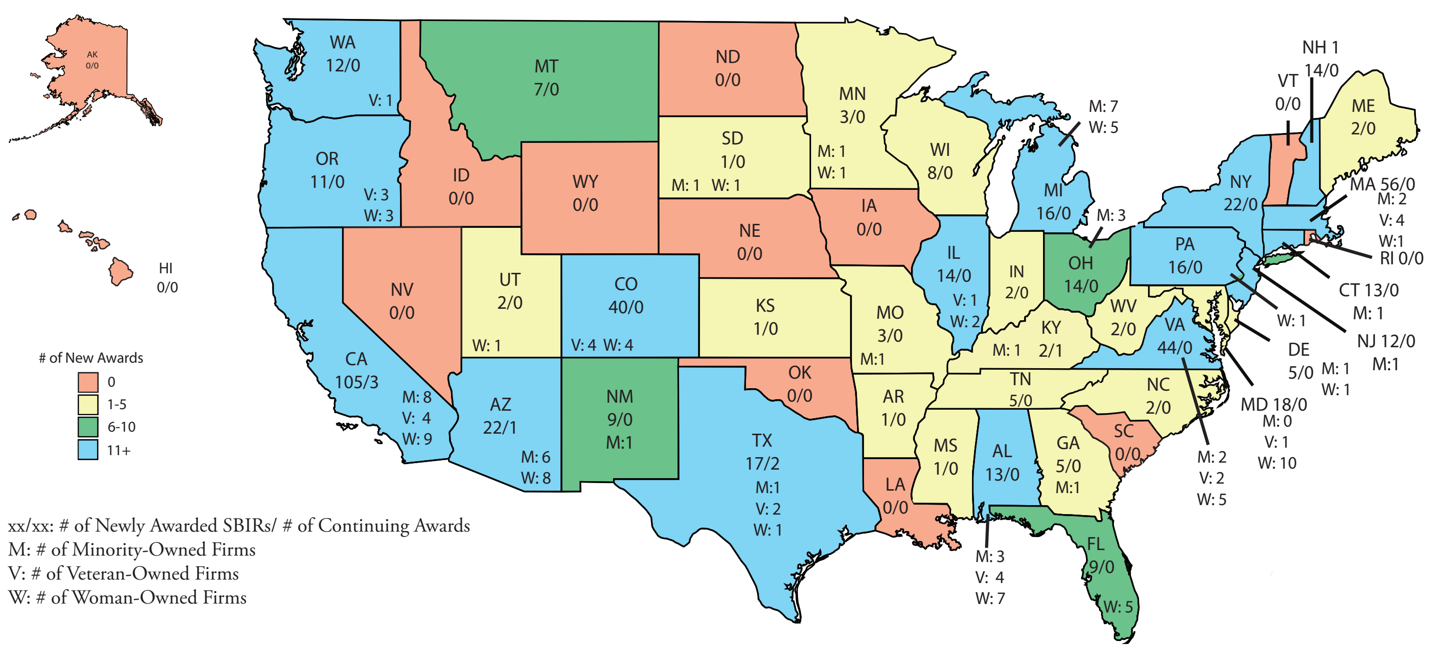
Small Business Innovation Research

FY2013

$132.5M
FY 2013 Annual Budget

$132M
Committed

$132M
Obligated



xx/xx: # of Newly Awarded SBIRs/ # of Continuing Awards
M: # of Minority-Owned Firms
V: # of Veteran-Owned Firms
W: # of Woman-Owned Firms

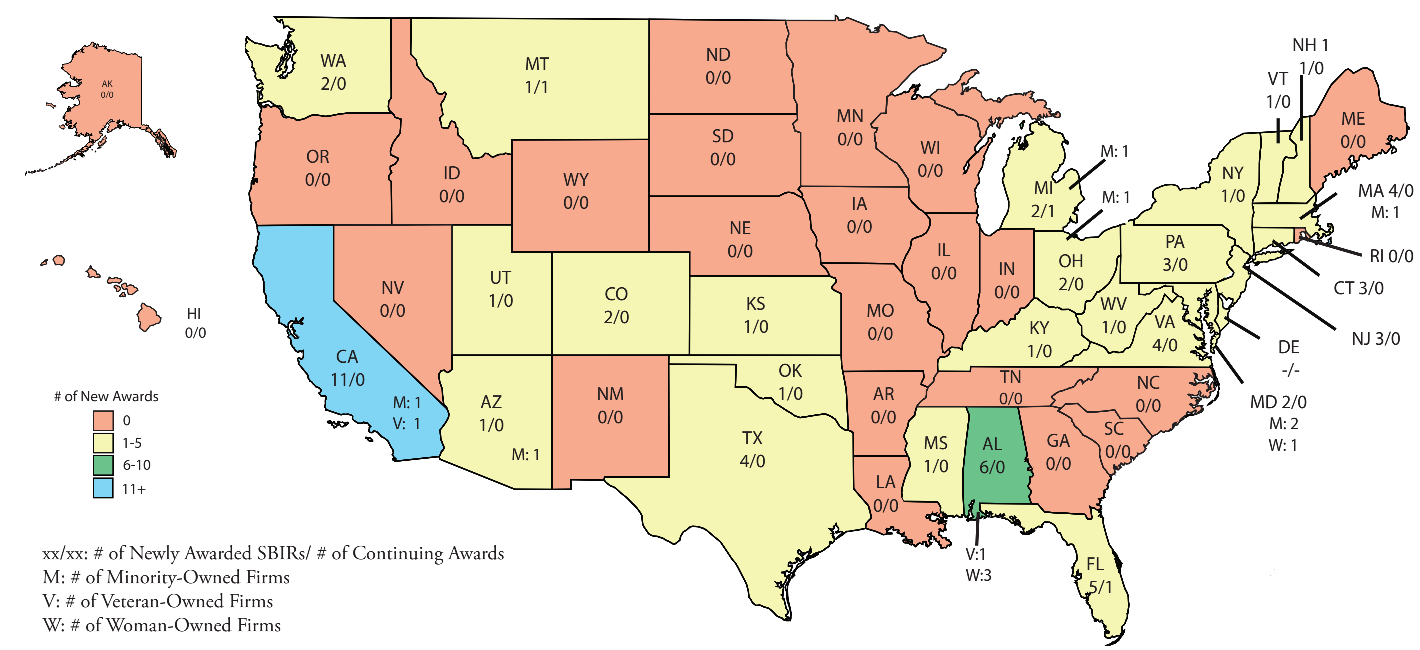
Small Business Technology TRansfer

FY2013

$18.5M
FY 2013 Annual Budget

$18.5M
Committed

$18.5M
Obligated



xx/xx: # of Newly Awarded SBIRs/ # of Continuing Awards
M: # of Minority-Owned Firms
V: # of Veteran-Owned Firms
W: # of Woman-Owned Firms

Highlighted Successes

Success Stories capture technology innovations spanning several years, involving multiple industries and dual use technologies with commercial and space applications. A Success Story also captures the challenging task of transitioning and commercializing their technology from an idea into the market. These companies have successfully created new approaches and solutions resulting in improved capabilities not only for NASA but also for commercial markets.

Many of the SBIR/STTR Success Stories also describe how small businesses collaborate with universities, including private and public research institutions, and other government agencies to advance technology. In addition, Technical Accomplishments are highlighted to bring focus to technologies that have great potential, are in final development stages, and are technologies to look forward to in the coming years.

Aircraft of the Future

Enabling engineers to model, simulate, analyze, and develop control laws so that future flexible vehicles can fly safely, comfortably, and efficiently.

Top photo: X-56A taxiing on the ground (Credit: NASA Photo / Ken Ulbrich). Bottom image: This artist's rendering shows a notional concept for a future supersonic commercial aircraft that potentially could go into service in the years 2030 to 2035 (Credit: The Boeing Company). Right Page: Artist Concept of NASA's X-56A MUTT aircraft (Credit: AFRL / Lockheed).

Lightweight flexible aircraft may be the next generation of vehicles that fly in our airspace. They can reduce the cost of air travel and extend aircraft flight distances because there is less wing structure compared to conventional fixed wing aircraft, making them lighter and more energy-efficient. More energy efficient aircraft will lead to reduced greenhouse gases which is important as air travel consumes around 1.5 billion barrels of Jet A-1 fuel annually and contributes 4-9% of the CO2 produced. However, with less structure the wings will bend and twist more easily in flight, which may result in uncontrollable vibrations called flutter, a destructive phenomenon that can cause the wings to break apart.

NASA Collaboration

Under a NASA **Small Business Innovation Research Program (SBIR)** contract from Dryden Flight Research Center, MUSYN Inc. has developed innovative modeling, simulation and control design tools for analyzing and suppressing flutter and gust loads for flexible aircraft. With a planned commercial

MUSYN's LPVTools provides a unifying software framework that will transform how industry approaches flight control design and analysis, for flexible aircraft as well as intelligent ground vehicles, transportation systems, medical systems, and industrial machinery and processes.

release in 2014, this tool will allow engineers to model, simulate, analyze, and develop control laws so that future flexible vehicles can fly safely, comfortably, and efficiently.

Filling the Gap

MUSYN developed LPVTools, a Linear Parameter-Varying (LPV) Control software toolkit, to study active control techniques for flutter suppression and gust load alleviation in a 2010 NASA SBIR Phase I contract. The LPV framework was initially developed in the late 1980s to analyze ubiquitous gain-scheduled controllers. Gain-scheduling has long been the traditional flight control design approach for aerospace vehicles as it allows the control of a system which cannot comply with a single operating point. Using multiple controllers, each set for a specific operating point, allows control across the region. Some of the first applications of the LPV framework were for general aircraft flight control and it has since been applied in a wide array of fields, including automotive, space, robotics, and computing systems. The LPV paradigm has been expanded to include algorithms for modeling, analysis, control design, system identification and fault detection. Despite the successes of the LPV paradigm in the aerospace industry, the field has lacked access to LPV software tools. MUSYN's LPVTools will fill this gap. The LPVTools software is being used to synthesize flight control algorithms for the X-56A with flight tests planned in 2014.

Innovative Partnerships

Due to the success of their Phase I contract, a follow on Phase II was awarded to expand the existing toolkit to be used on NASA Aeronautics' X-56A Multi Utility Technology Testbed (MUTT) and towards applications for general aerospace vehicles. The MUTT is a new experimental aircraft being developed by the Air Force Research Laboratory and Lockheed Martin to study aeroelastic phenomena in flexible aircraft. It is a small jet powered unmanned aircraft, at just 7.5-foot-long with a 28-foot wingspan. The wings of the MUTT aircraft can be made very flexible, allowing the aircraft to experience flutter and as a result provide the necessary data for the development of the LPVTools software.

Taking Control

One goal of the X-56A MUTT project is to study the effectiveness of using ordinary aircraft control surfaces to lessen the effects of flutter and gust disturbances by incorporating flutter suppression algorithms into the flight control system. The X-56A provides a challenging platform due to its very flexible wings. Very flexible aircraft have flutter modes within the frequency bandwidth of the flight control system, which requires the flexible modes to be actively controlled in flight. Failure to control these flutter modes can lead to oscillations that can destroy a vehicle. Current aircraft flight control systems are designed independently from flutter suppression and gust load alleviation systems.

Artist's rendering of X-56A MUTT package, consisting of the aircraft with three additional wing sets and a second fuselage/mid-body (center), flanked by the ground control station on the left and the air vehicle storage/transport trailer on the right. (AFRL/Lockheed image)

MUSYN's LPVTools is a modeling, analysis and control design tool that will synthesize flight control algorithms that will operate in real-time onboard the X-56A to minimize the flutter motion of the aircraft by commanding the aircraft's control surfaces. A successful experimental demonstration of flutter suppression algorithms onboard the X-56A is an important step toward making lightweight flexible aircraft technically feasible.

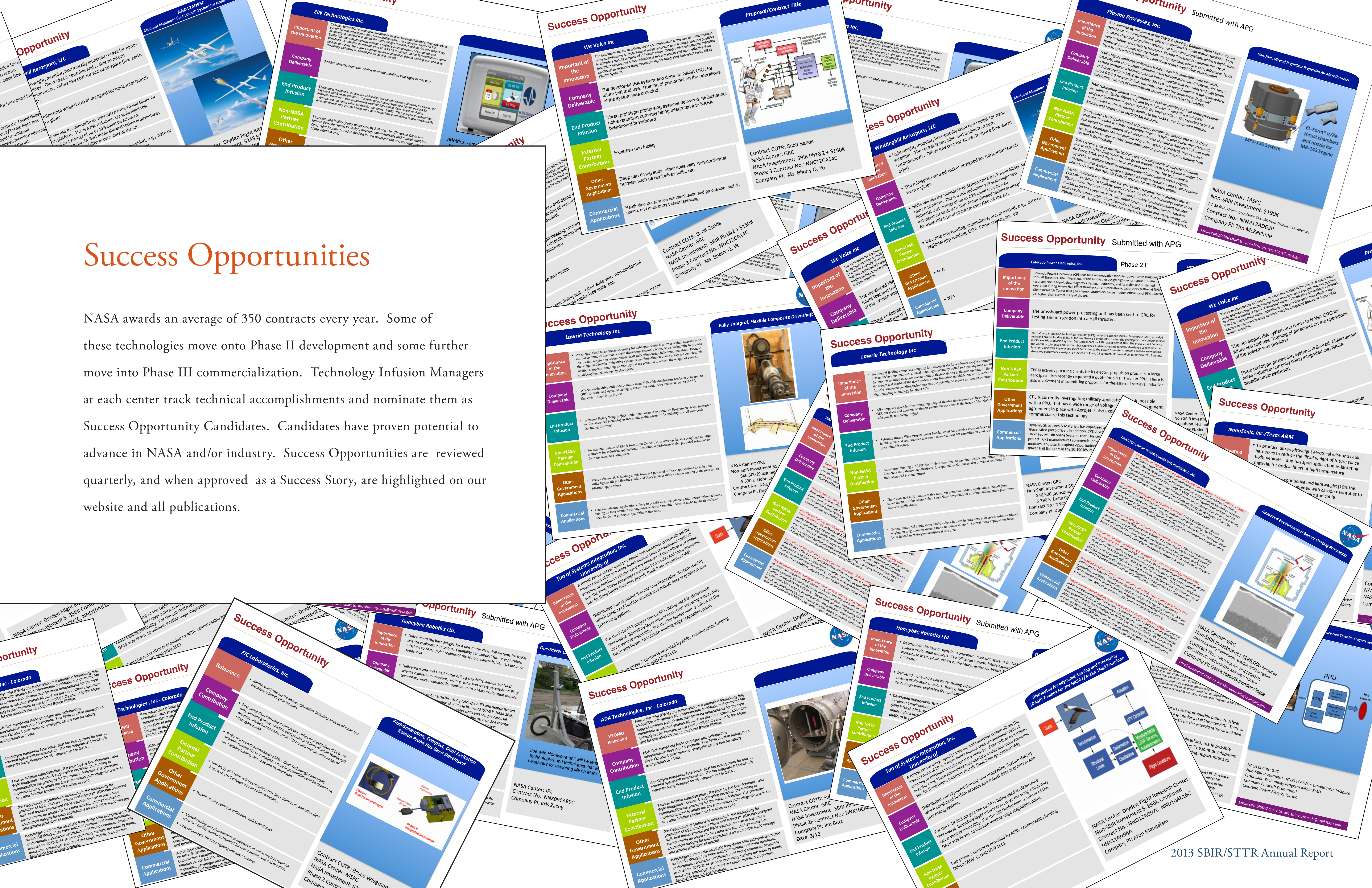
Flying into the Future

Technologies for improved control law analysis and synthesis will offer clear advantages for a number of aerospace systems, including military fixed-wing aircraft and helicopters, Uninhabited Aerial Systems (UAVs), launch platforms, re-entry vehicles, spacecraft, and commercial aircraft. The performance and safety of future lightweight, environmentally friendly engineered systems (e.g. wind turbines, ground vehicles, trains, etc.) will require advanced control systems which directly handle flexible dynamics. LPV control techniques have already been demonstrated for the control of aircraft, launch vehicles, automotive suspensions, trucks, missiles and underwater vehicles. MUSYN's LPVTools provides a unifying software framework that will transform how industry approaches flight control design and analysis, for flexible aircraft as well as intelligent ground vehicles, transportation systems, medical systems, and industrial machinery and processes.

Dryden Flight Research Center

Authors: Arnar Hjartarson (MUSYN)
Marty Brenner (NASA)
Gary Balas (MUSYN)

For more information:
www.sbir.nasa.gov | www.musyn.com



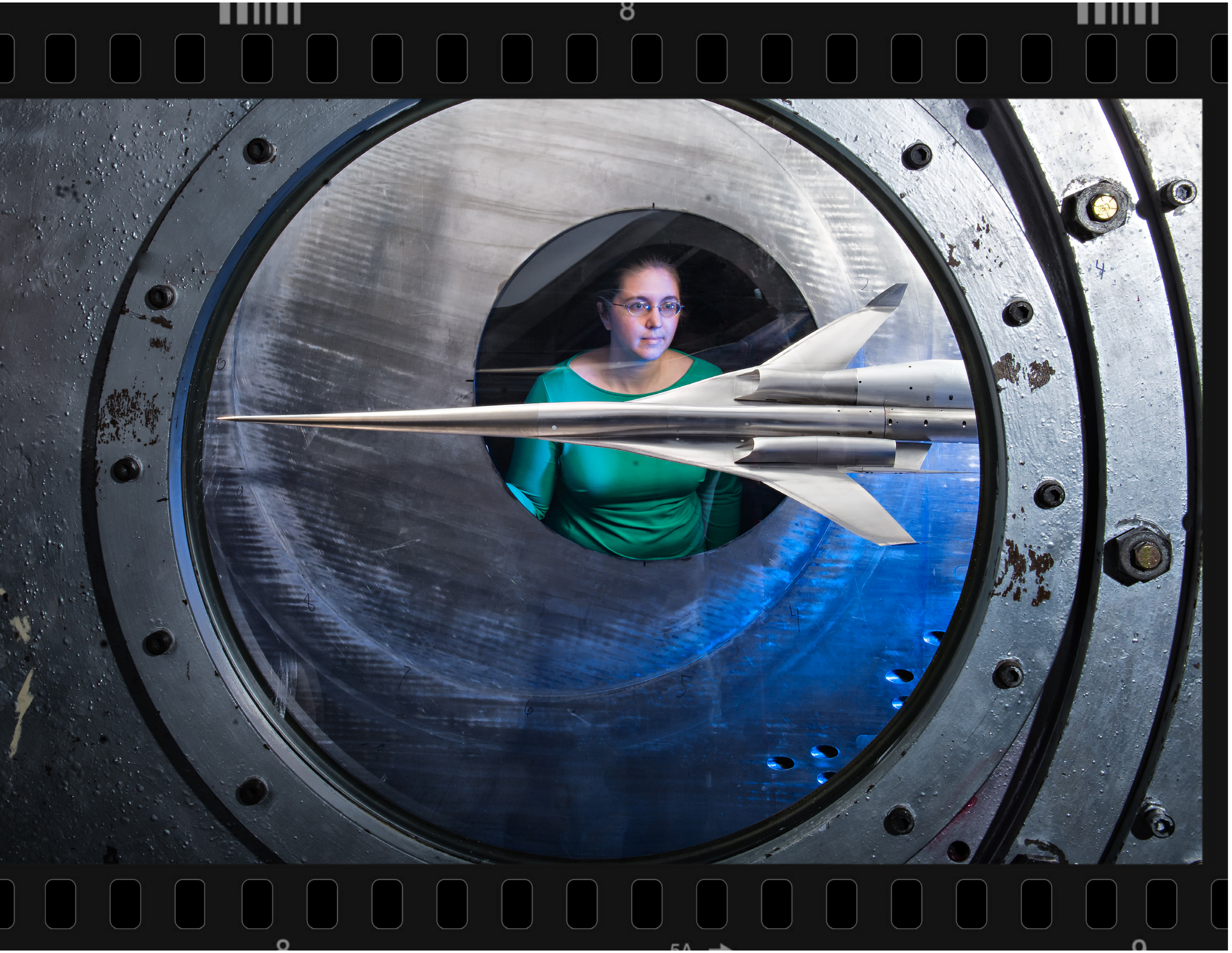
Success Opportunities

NASA awards an average of 350 contracts every year. Some of these technologies move onto Phase II development and some further move into Phase III commercialization. Technology Infusion Managers at each center track technical accomplishments and nominate them as Success Opportunity Candidates. Candidates have proven potential to advance in NASA and/or industry. Success Opportunities are reviewed quarterly, and when approved as a Success Story, are highlighted on our website and all publications.

Success Opportunities by Center

Center	Company Name	Technology Title
JPL	PolarOnyx, Inc.	Development work lead to a commercial product line with $1 million in sales
MSFC	EIC Laboratories, Inc.	First-Generation, Compact, Dual-Excitation Raman Probe Has Been Developed
MSFC	AI Signal Research (ASRI), Inc.	PC-Signal® Continues to Evolve to Meet NASA's Needs
GRC	Zin Technologies	Compact wireless biometric monitoring and real time processing system
GRC	Deployable Space System	Large Power Solar Arrays Based on the Roll-Out Solar Array
GRC	Nanosonic Inc.	Lightweight Metal Rubber Wire and Cable for Space Power Systems
JSC	Intelligent Optical Systems	Miniature sensor probe for O2, CO2, and H2O monitoring in space suits
JSC	Linea Research Corp.	Wearable Beat to Beat Blood Pressure Monitor
JSC	Orbital Technologies Corp.	Just in Time Simulation (JITS) Platform
JSC	Operational Technologies Corp.	Handheld FRET-Aptamer Sensor for Bone Markers
KSC	Honeybee Robotics	Pneumatic Regolith Transfer for Lunar ISRU
DFRC	Tao Systems Integration, Inc.	Distributed aerodynamic sensing and processing system for physics based flowfield measurements.
GRC	ADA Technologies	Advanced Portable Fine Water Mist Fire Extinguisher for Spacecraft
GRC	WeVoice	Microphone Array Signal Processing and Active Noise Control for the In-Helmet Speech Communication
JPL	honeybee roboticswww	One-Meter Class Drilling for Planetary Exploration
MSFC	Plasma Data	Non-Toxic (Green) Propellant Propulsion for Microthrusters
GRC	Directed Vapor	Advanced Environmental Barrier Coating (EBC) Processing
DFRC	Whittinghill	Horizontally launched rocket for towed glider payload deployment
JSC	Tier 1 Performance	Human Factors Analysis Support Tool (H-FAST)
JSC	Creare , Inc.	Nonventing Thermal and Humidity Control for EVA Suits
JSC	TRS Ceramics	Cryogenic Fluid Transfer Components Using Single Crystal Piezoelectric Actuators
JSC	TechShot	Bone Densitomiter
JPL	Boston Micromachine Corporation	Ultra Flat Tip-Tilt-Piston MEMS Deformable Mirror
JPL	Colorado Power Electronics, Inc.	Wide Output Range Power Processing Unit for Electric Propulsion
JPL	Vanguard Space Technologies, Inc.	Lightweight Thermally Stable Multi-meter Large Submillimeter Reflectors

Center	Company Name	Technology Title
JPL	Designs & Prototypes	Portable FTIR Spectrometer
GRC	Lawrie Technology Inc.	Composite Drive Shaft Systems
GFRC	Fibertek, Inc.	Two Laser Transmitter Units and Associated Electronic
GFRC	Michigan Aerospace Corporation	Tunable Fabry-Perot Interferometer and Controller Electronic
GRC	Colorado Power Electronics, Inc	Low-Cost High-Performance Hall Thruster Support System
KSC	Blue Sun Enterprises	Development, Optimization and Testing of Virtual Machine Language for the RESOLVE Vacuum Development Unit Payload
KSC	Astrobotic Technology, Inc..	Regolith and Environment Science & Oxygen and Lunar Volatile Extraction (RESOLVE)
KSC	Creare, Inc	Delivery and Support of a Risk Reduction Sample Delivery System
LARC	Coherent Technical Services	Avionics for Scaled Remotely Operated Vehicles
LARC	MYMIC, LLC	Virtual Environment Cryogenic Tunnel Training System
DFRC	Tao of Systems Integration, Inc..	Vorticity State Estimator for Aeroelastic Control
GFSC	Virginia Diodes, Inc.	High Reliability Oscillators for Terahertz Systems
GFSC	Parabon Computation, Inc	Software Infrastructure to Enable Modeling & Simulation as a Service (M&SaaS)
GRC	Cateni, Inc	Navigation and Timing Analysis
JPL	Bear Technologies, LLC	Design and Modeling of a Revolutionary Commercial High Torque Motor
JSC	TDA Research, Inc	Rapid Cycling CO2 and H2O Removal System for EM
JSC	Techshot, Inc	Life Science Research Sample Transfer Technology For On Orbit Analysis
KSC	Quest Thermal Group, LLC	Integrated Multi-Layer Insulation Thermal Coupons
MFSC	Precision Combustion, Inc.	Catalytic Oxidizer for the Oxygen Generator Assembly Development Effort
MFSC	Giner, Inc.	Cathode Feed Electrolysis Cell Stack Development Effort
SSC	Sierra Lobo, Inc	Gaseous Helium Reclamation at Rocket Test Systems
SSC	StormCenter Communications, Inc	A Robust Real-Time Collaboration Technology for Decision Support in Multi-Platform Virtual Globe Environments
LARC	Applied University Research	Transonic Juncture Flow Wind Tunnel Experiments: LDV Hardware, Software and Experiment Design



Economic Impact

This brief overview of the program's annual economic impact analysis; created using widely accepted and industry-standard "input-output" modeling software, quantifies the many positive economic implications of NASA's SBIR and STTR programs, including:

- increased employment
- gross national product
- earnings and wages

2013 was the first year in which the program management office performed such a thorough employment and economic impact analysis. The results revealed that NASA's SBIR and STTR program plays an important role within not only the Nation's research and development sector but also the economy as a whole.

Economic Impact Analysis

In 2013 (FY2012), NASA SBIR program management commissioned an economic impact analysis with the anticipated result of quantifying the estimated national economic and fiscal impact of NASA SBIR and STTR investments. The study was successfully completed using the industry-standard input-output modeling software IMPLAN. Based off a framework developed by Nobel Prize winning economist Wassily Leontief, IMPLAN is a static-equilibrium economic model that calculates the employment, output (GDP), and tax effects of a specific economic activity or set of activates. In total, NASA SBIR and STTR small businesses received approximately $158.480 million ($139.95 million allocated to SBIR participating small businesses and $1853 million allocated to STTR participating small businesses) for the development of R&D technologies.

Table 1 - NASA SBIR and STTR Obligated Funding for FY12

Program	Obligated Funding
SBIR	$139.95M
STTR	$18.53M
Total	$158.48M

The investments and subsequent economic and fiscal impact of the STTR and SBIR programs propagate through-out the United States. While small businesses from 38 states received awards, the economic effects occurred nation-wide, as supplier and income effects nevertheless occur in states in which no small businesses received awards. The economic and fiscal impact stemming from the program's investments are listed in the table below.

Table 2 - Total Economic Impact of NASA SBIR and STTR Obligated Funding

	SBIR	STTR	Total
Total Investment	$139.95M	$18.53M	$158.48M
Total Economic Impact			
Employment (jobs)	3,341	442	3,800
Labor Income ($ millions)	$227.17	$30.07	$257.25
Output ($ millions)	$557.68	$73.84	$631.53
Total Fiscal Impact			
	SBIR	**STTR**	**Total**
Total Taxes ($ millions)	$63.78	$8.44	$72.23
Federal ($ millions)	$42.63	$5.64	$48.27
State and Local ($ millions)	$21.15	$2.80	$23.95

Figure 1– Return on investment: Output and Earnings Increase

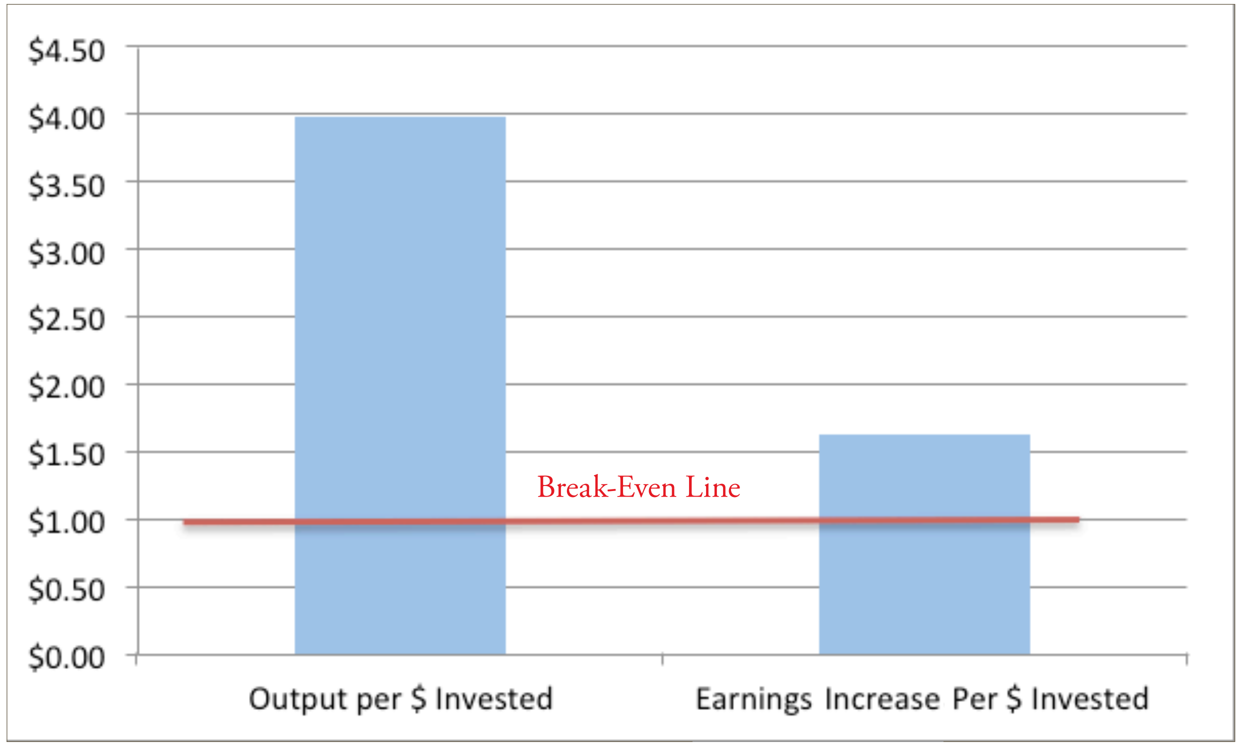


Figure 1 shows nearly a $4.00 return on investment for every dollar invested by the SBIR and STTR programs into American small businesses as a ration of Total Economic Output to Total Investment. It also indicates that the programs increased worker earnings by $1.62 for every dollar invested in the program as a ration of Total Increase in Earnings to Total Investment. These are net-positive returns on investment by the program and show that the program no-only contributes to the strong research and develop base within the country but has measurable economic benefits as well.

The total economic impact of NASA SBIR and STTR investment takes place across various national industries by means of indirect and induced economic effects. Table 4 displays the 10 most impacted industries (by employment) due to NASA SBIR and STTR investment.

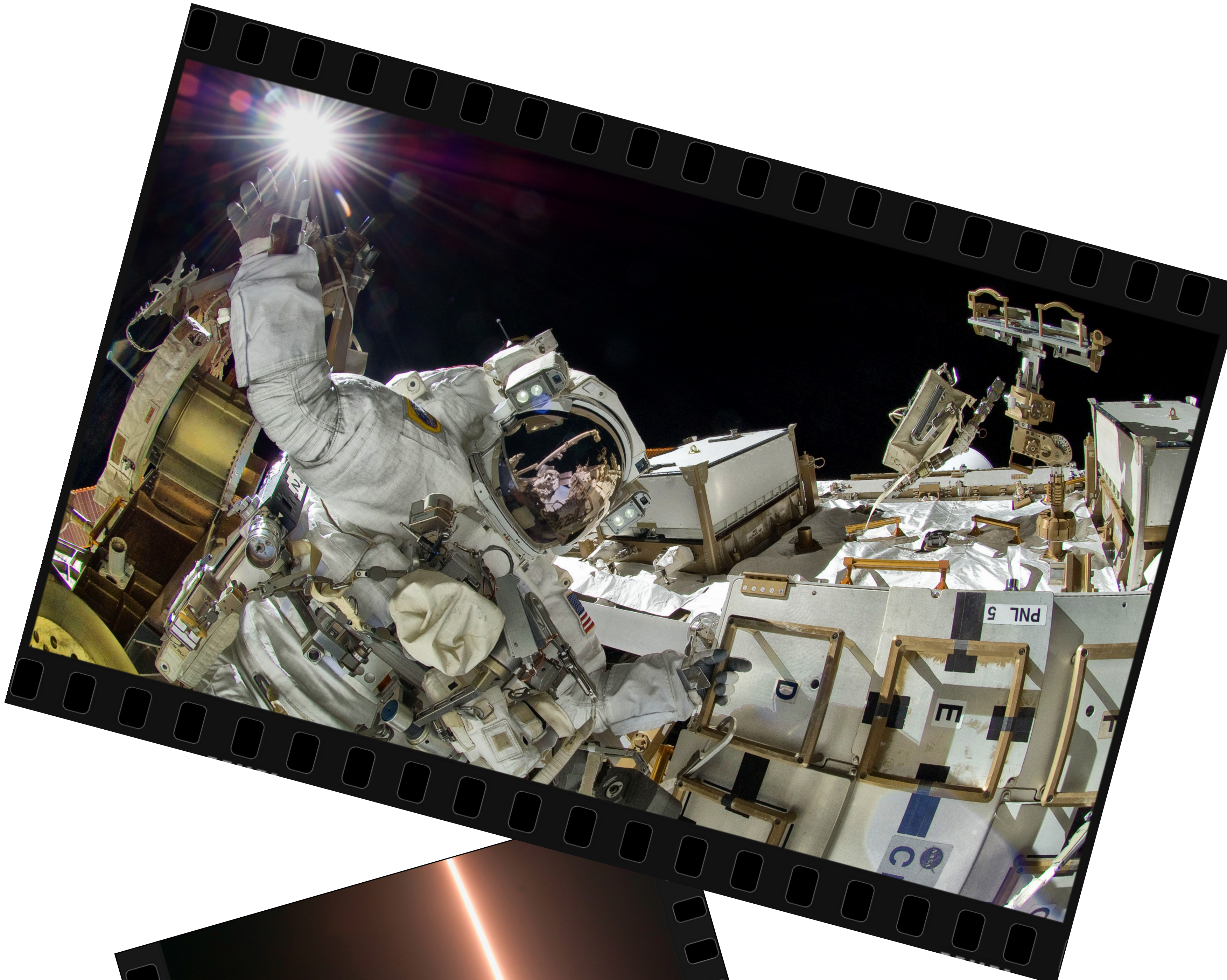
Most of the impacts occur in the scientific research and development services, because the industry impacts reflect the nature of the NASA's investment. However, service industries, real estate, and healthcare industries (all major components of the U.S. economy) also received a large share of the economic benefits from NASA's initial investment.

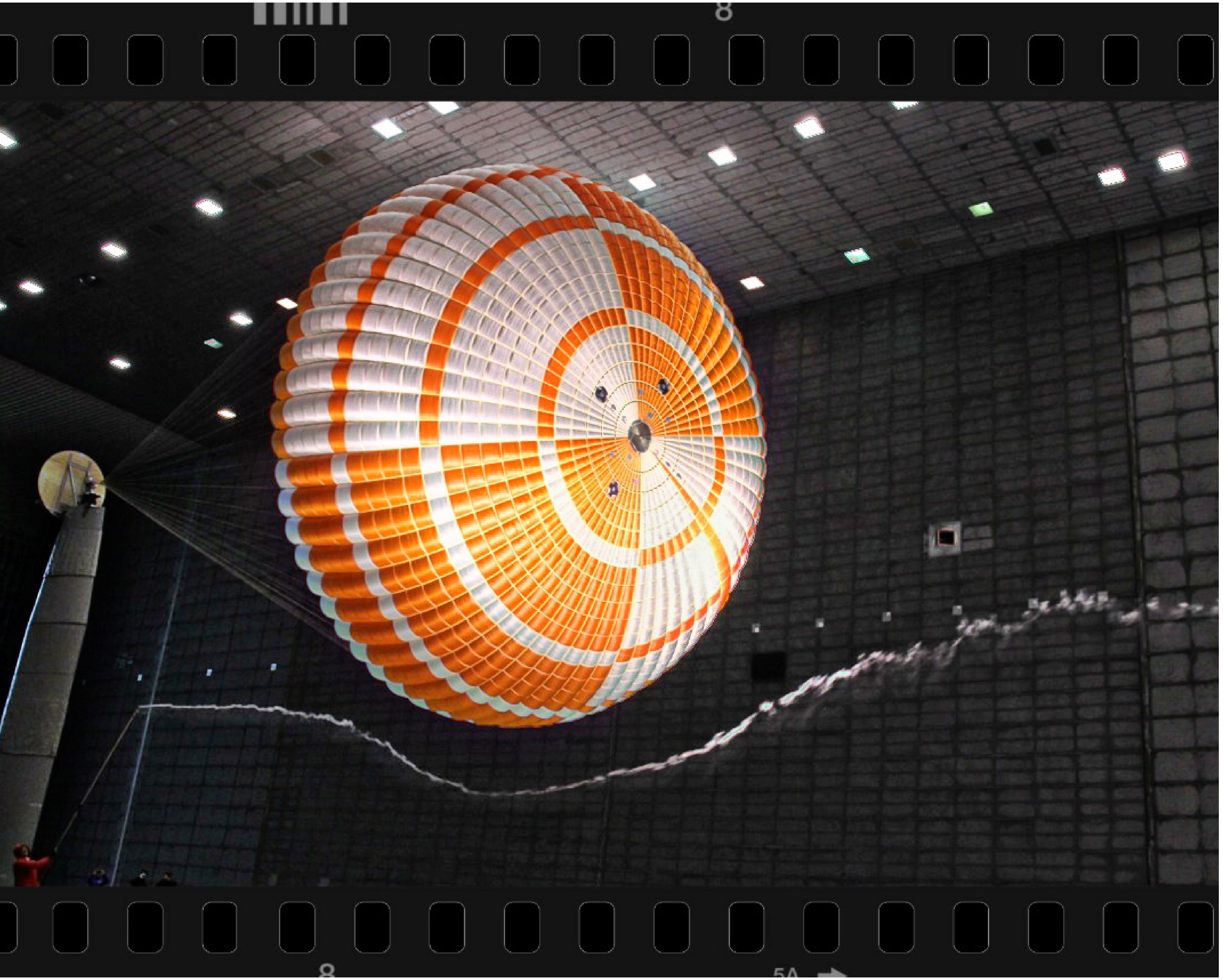
Table 3- Top 10 Impacted Industries (Based Upon Employment Impacts)

IMPLAN Sector	Description	Employment	Labor Income (Millions $)	Output
376	Scientific research and development services	1,245.4	$130.52	$244.99
413	Food services and drinking places	197.8	$4.44	$11.77
360	Real estate establish-ments	127.8	$1.99	$20.53
382	Employment services	126.8	$4.00	$5.44
388	Services to buildings and dwellings	124.3	$3.22	$7.24
39	Maintenance and repair construction of nonresidential struc-tures	93.2	$5.31	$9.60
394	Offices of physicians, dentists, and other health practitioners	70.9	$5.72	$9.15
397	Private hospitals	68	$4.74	$9.65
319	Wholesale trade busi-nesses	63.2	$5.04	$11.70
356	Securities, commodity contracts, investments, and related activities	59.3	$3.90	$10.48

*Please note that the values in the figure should be interpreted as illustrative of industry effects rather than precise given model and data limitations.

The study made clear that NASA's SBIR and STTR programs play an important role not only within the Nation's research and development sector, but within the economy as a whole. In total, $158.4 million in NASA SBIR and STTR funds created or retained approximately 3,340 American jobs, $257.2 million in additional wages, and $631.5 million in Gross Domestic Product (GDP). $48.2 million in federal tax income was created and NASA's awards also generated an estimated $23.9 million in taxes for State and Local jurisdictions. Further information, including the economic impact report in its entirety, can be found at NASA's SBIR Program website.





Mission Directorate & Technology Area Investments

NASA's SBIR & STTR Programs invest in many different research areas. The following tables break down the program's Phase II investments into 4 views:

1. Mission Directorate Investments by Technology Area
   FY 2009-2013 (see note about ARMD below)
2. SBIR Combined Investments by Technology Area
   FY 2009-2013 (HEOMD & SMD)
3. Mission Directorate Investments by Technology Area
   FY 2013 (see note about ARMD below)
4. SBIR Combined Investments by Technology Area
   FY 2013 (HEOMD & SMD)

The past 5 years have brought about programmatic changes as noted below:

- Space Technology Mission Directorate (STMD) is a newly created Mission Directorate (MD) and therefore has not been included in the calculations.
- Prior MDs, Space Operations Mission Directorate (SOMD) and Exploration Systems Mission Directorate (ESMD), have merged to form Human Exploration and Operations Mission Directorate (HEOMD).
- The Aeronautics Mission Directorate (ARMD) does not fall under any TA, therefore, ARMD is broken down by SBIR's solicitation topic/subtopic areas and not included in the SBIR Combined Investments tables.

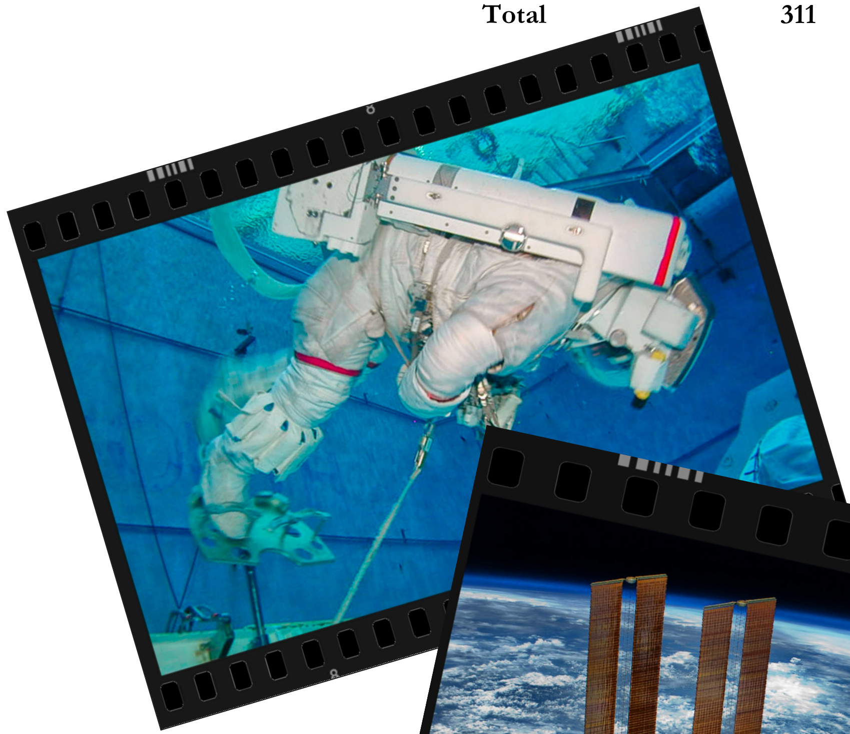
HEOMD Investments by Technology Area

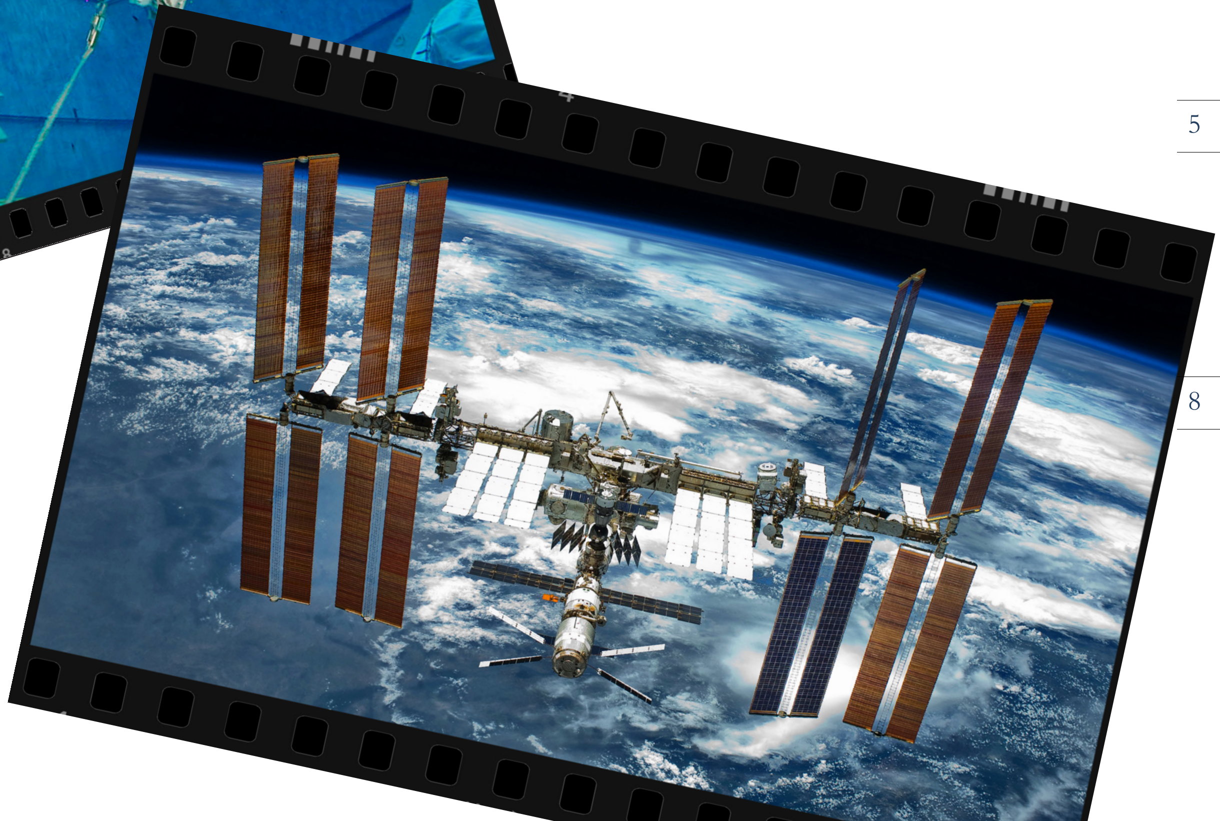
FY 2009- 2013 Phase II Awards

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
1 Launch Propulsion Systems		**10**	**$6,295,417**
	1.1 Solid Rocket Propulsion Systems	1	$750,000
	1.2 Liquid Rocket Propulsion Systems	6	$3,745,534
	1.4 Ancillary Propulsion Systems	3	$1,799,883
2 In-Space Propulsion Technologies		**25**	**$15,833,752**
	2.1 Chemical Propulsion	9	$5,790,443
	2.2 Non-Chemical Propulsion	3	$1,999,505
	2.3 Advanced (TRL <3) Propulsion Technologies	1	$749,958
	2.4 Supporting Technologies	12	$7,293,846
3 Space Power and Energy Storage		**21**	**$13,329,402**
	3.1 Power Generation	6	$4,183,737
	3.2 Energy Storage	12	$7,345,935
	3.3 Power Management and Distribution	3	$1,799,730
4 Robotics, Tele-Robotics and Autonomous Systems		**39**	**$24,523,537**
	4.1 Sensing & Perception	4	$2,399,372
	4.2 Mobility	3	$1,949,014
	4.3 Manipulation	3	$1,877,090
	4.4 Human-Systems Integration	4	$2,649,165
	4.5 Autonomy	13	$8,304,356
	4.6 Autonomous Rendezvous and Docking	2	$1,199,371
	4.7 RTA Systems Engineering	10	$6,145,169
5 Communications and Navigation		**47**	**$29,268,870**
	5.1 Optical Comm. And Navigation	9	$5,645,941
	5.2 Radio Frequency Communications	13	$7,881,156
	5.3 Internetworking	2	$1,199,975
	5.4 Position, Navigation, and Timing	13	$8,244,792
	5.5 Integrated Technologies	9	$5,699,758
	5.6 Revolutionary Concepts	1	$597,248

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
6 Human Health, Life Support & Habitation Systems		**75**	**$47,691,755**
	6.1 Environmental Control Life Support & Habitation Systems	16	$10,045,689
	6.2 Extravehicular Activity Systems	10	$6,348,995
	6.3 Human Health and Performance	34	$21,647,818
	6.4 Environmental Monitoring and Safety	11	$6,999,429
	6.5 Radiation	4	$2,649,824
7 Human Exploration Destination Systems		**31**	**$19,272,918**
	7.1 In-Situ Resource Utilization	17	$10,590,705
	7.2 Sustainability & Supportability	5	$3,296,322
	7.3 Advanced Human Mobility Systems	2	$1,199,561
	7.6 Cross-Cutting Systems	7	$4,186,330
8 Science Instruments, Observatories & Sensor Systems		**4**	**$2,498,908**
	8.1 Science Instruments	3	$1,898,908
	8.2 Observations	1	$600,000
9 Entry, Descent and Landing Systems		**4**	**$2,498,714**
	9.1 Aeroassist & Entry	3	$1,898,734
	9.4 Vehicle Systems Technology	1	$599,980
10 Nanotechnology		**4**	**$2,599,551**
	10.1 Engineered Materials and Structures	2	$1,199,934
	10.4 Electronics, Sensors and Devices	2	$1,399,617
11 Modeling, Simulation, Information Technology and Processing		**8**	**$4,946,886**
	11.2 Modeling	8	$4,946,886
12 Materials, Structures, Mechanical Systems and Manufacturing		**23**	**$14,082,550**
	12.1 Materials	9	$5,549,502
	12.2 Structures	3	$1,799,866
	12.3 Mechanical Systems	4	$2,399,672
	12.4 Manufacturing	6	$3,748,149
	12.5 Cross-Cutting	1	$585,361

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
13 Ground and Launch Systems Processing		12	$7,547,220
	13.1 Technologies to Optimize the Operational Life-Cycle	1	$599,483
	13.2 Environmental and Green Technologies	3	$1,899,911
	13.3 Technologies to Increase Reliability and Mission Availability	6	$3,847,925
	13.4 Technologies to Improve Mission Safety/Mission Risk	2	$1,199,901
14 Thermal Management Systems		8	$5,048,399
	14.1 Cryogenic Systems	2	$1,299,816
	14.2 Thermal Control Systems	6	$3,748,583
	Total	**311**	**$195,437,879**



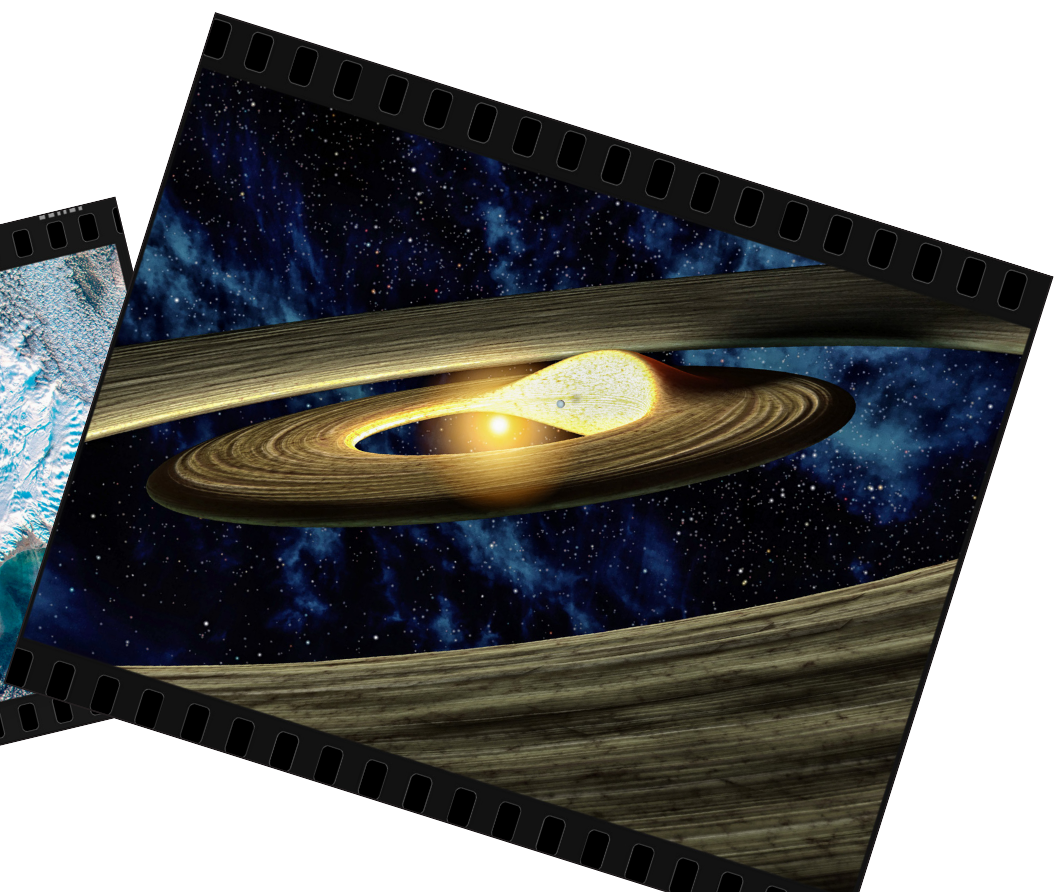


SMD Investments by Technology Area

FY 2009- 2013 Phase II Awards

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
1 Launch Propulsion Systems		5	$2,992,324
	1.1 Solid Rocket Propulsion Systems	1	$599,674
	1.2 Liquid Rocket Propulsion Systems	1	$599,922
	1.4 Ancillary Propulsion Systems	2	$1,193,155
	1.5 Unconventional/Other Propulsion Systems	1	$599,573
2 In-Space Propulsion Technologies		21	$13,221,610
	2.1 Chemical Propulsion	5	$3,091,872
	2.2 Non-Chemical Propulsion	14	$8,779,769
	2.4 Supporting Technologies	2	$1,349,969
3 Space Power and Energy Storage		15	$9,445,989
	3.1 Power Generation	12	$7,447,384
	3.2 Energy Storage	1	$599,890
	3.3 Power Management and Distribution	2	$1,398,715
4 Robotics, Tele-Robotics and Autonomous Systems		14	$8,380,008
	4.1 Sensing & Perception	1	$600,000
	4.2 Mobility	2	$1,196,795
	4.3 Manipulation	7	$4,183,536
	4.5 Autonomy	2	$1,199,965
	4.6 Autonomous Rendezvous and Docking	2	$1,199,712
5 Communications and Navigation		14	$8,771,710
	5.1 Optical Comm. And Navigation	5	$2,999,386
	5.2 Radio Frequency Communications	2	$1,190,115
	5.4 Position, Navigation, and Timing	6	$3,843,550
	5.5 Integrated Technologies	1	$738,659
8 Science Instruments, Observatories & Sensor Systems		134	$85,204,787
	8.1 Science Instruments	82	$52,351,597
	8.2 Observations	23	$14,319,788
	8.3 Sensor Systems	29	$18,533,402

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
9 Entry, Descent and Landing Systems		**12**	**$7,555,754**
	9.1 Aeroassist & Entry	1	$599,981
	9.3 Landing	2	$1,291,623
	9.4 Vehicle Systems Technology	9	$5,664,150
10 Nanotechnology		**3**	**$1,799,885**
	10.1 Engineered Materials and Structures	3	$1,799,885
11 Modeling, Simulation, Information Technology and Processing		**15**	**$9,489,041**
	11.1 Computing	2	$1,199,914
	11.2 Modeling	3	$1,898,521
	11.3 Simulation	1	$599,951
	11.4 Information Processing	9	$5,790,655
13 Ground and Launch Systems Processing		**1**	**$600,000**
	13.1 Technologies to Optimize the Operational Life-Cycle	1	$600,000
14 Thermal Management Systems		**11**	**$6,898,244**
	14.1 Cryogenic Systems	9	$5,699,263
	14.2 Thermal Control Systems	2	$1,198,981
	Total	**245**	**$154,359,352**



ARMD Investments by Topic and Subtopic Area

FY 2009- 2013 Phase II Awards

Topic Area	Subtopic Area	Number of Awards	Award Amount
A1 Aviation Safety		**36**	**$22,619,635**
	Adaptive Aeroservoelastic Suppression	2	$1,331,114
	Adaptive Flight Control	1	$600,000
	Adaptive Structural Mode Suppression	1	$599,902
	Aircraft Aging and Durability	2	$1,199,972
	Aviation External Hazard Sensor Technologies	5	$3,245,923
	Crew Systems Technologies for Improved Aviation Safety	3	$1,795,474
	Data Mining	2	$1,349,953
	Detection and Diagnosis of Aircraft Anomalies	5	$3,148,613
	Engine Lifing and Prognosis for In-Flight Emergencies	1	$599,932
	Integrated Avionics Systems for Small Scale Remotely Operated Vechicles	1	$599,948
	Integrated Vehicle Health Management	1	$599,988
	On-Board Flight Envelope Estimation for Unimpaired and Impaired Aircraft	1	$599,991
	Pilot Interactions with Adaptive Control Systems under Off-Nominal Conditions	1	$599,972
	Robust Flare Planning and Guidance for Unimpaired and Impaired Aircraft	1	$599,898
	Sensing and Diagnostic Capability	4	$2,549,524
	Technologies for Improved Design and Analysis of Flight Deck Systems	2	$1,199,996
	Unmanned Vehicle Design for Loss-of-Control Flight Research	1	$699,962
	Verification and Validation of Flight-Critical Systems	2	$1,299,473
A2 Fundamental Aeronautics		**57**	**$35,690,217**
	Aero-Acoustics	5	$3,243,523
	Aerodynamics	3	$1,799,566
	Aeroelasticity	7	$4,299,602
	Aerothermodynamics	4	$2,549,848
	Aircraft Systems Analysis, Design and Optimization	5	$3,233,580
	Combustion for Aerospace Vehicles	8	$4,946,919
	Experimental Capabilities and Flight Research	2	$1,199,925
	Flight and Propulsion Control and Dynamics	2	$1,349,871

Topic Area	Subtopic Area	Number of Awards	Award Amount
	Materials and Structures for Future Aircraft	10	$6,087,280
	Propulsion Systems	3	$1,945,761
	Rotorcraft	8	$5,034,342
A3 Airspace Systems		**17**	**$10,676,358**
	Concepts and Technology Development (CTD)	3	$2,149,998
	NextGen Airportal	5	$2,771,334
	NextGen Airspace	6	$3,555,180
	Systems Analysis Integration Evaluation (SAIE)	3	$2,199,846
A4 Aeronautics Test Technologies		**12**	**$7,697,369**
	Ground and Flight Test Techniques and Measurement Technologies	10	$6,497,431
	Test Measurement Technology	2	$1,199,938
A5 Integrated System Research Project (ISRP)		**2**	**$1,399,516**
	Unmanned Aircraft Systems Integration into the National Airspace System Research	2	$1,399,516
	Total	**124**	**$78,083,095**

SBIR Combined Investments by Technology Area

FY 2009- 2013 Phase II Awards (HEOMD & SMD)

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
1 Launch Propulsion Systems		**15**	**$9,287,741**
	1.1 Solid Rocket Propulsion Systems	2	$1,349,674
	1.2 Liquid Rocket Propulsion Systems	7	$4,345,456
	1.4 Ancillary Propulsion Systems	5	$2,993,038
	1.5 Unconventional/Other Propulsion Systems	1	$599,573
2 In-Space Propulsion Technologies		**46**	**$29,055,362**
	2.1 Chemical Propulsion	14	$8,882,315
	2.2 Non-Chemical Propulsion	17	$10,779,274
	2.3 Advanced (TRL <3) Propulsion Technologies	1	$749,958
	2.4 Supporting Technologies	14	$8,643,815
3 Space Power and Energy Storage		**36**	**$22,775,391**
	3.1 Power Generation	18	$11,631,121
	3.2 Energy Storage	13	$7,945,825
	3.3 Power Management and Distribution	5	$3,198,445
4 Robotics, Tele-Robotics and Autonomous Systems		**53**	**$32,903,545**
	4.1 Sensing & Perception	5	$2,999,372
	4.2 Mobility	5	$3,145,809
	4.3 Manipulation	10	$6,060,626
	4.4 Human-Systems Integration	4	$2,649,165
	4.5 Autonomy	15	$9,504,321
	4.6 Autonomous Rendezvous and Docking	4	$2,399,083
	4.7 RTA Systems Engineering	10	$6,145,169
5 Communications and Navigation		**61**	**$38,040,580**
	5.1 Optical Comm. And Navigation	14	$8,645,327
	5.2 Radio Frequency Communications	15	$9,071,271
	5.3 Internetworking	2	$1,199,975
	5.4 Position, Navigation, and Timing	19	$12,088,342
	5.5 Integrated Technologies	10	$6,438,417
	5.6 Revolutionary Concepts	1	$597,248

Level 1 TA	Level 2 TA		Number of Awards	Award Amount
6	Human Health, Life Support & Habitation Systems		**75**	**$47,691,755**
	6.1	Environmental Control Life Support & Habitation Systems	16	$10,045,689
	6.2	Extravehicular Activity Systems	10	$6,348,995
	6.3	Human Health and Performance	34	$21,647,818
	6.4	Environmental Monitoring and Safety	11	$6,999,429
	6.5	Radiation	4	$2,649,824
7	Human Exploration Destination Systems		**31**	**$19,272,918**
	7.1	In-Situ Resource Utilization	17	$10,590,705
	7.2	Sustainability & Supportability	5	$3,296,322
	7.3	Advanced Human Mobility Systems	2	$1,199,561
	7.6	Cross-Cutting Systems	7	$4,186,330
8	Science Instruments, Observatories & Sensor Systems		**4**	**$2,498,908**
	8.1	Science Instruments	3	$1,898,908
	8.2	Observations	1	$600,000
9	Entry, Descent and Landing Systems		**4**	**$2,498,714**
	9.1	Aeroassist & Entry	3	$1,898,734
	9.4	Vehicle Systems Technology	1	$599,980
10	Nanotechnology		**4**	**$2,599,551**
	10.1	Engineered Materials and Structures	2	$1,199,934
	10.4	Electronics, Sensors and Devices	2	$1,399,617
11	Modeling, Simulation, Information Technology and Processing		**8**	**$4,946,886**
	11.2	Modeling	8	$4,946,886
12	Materials, Structures, Mechanical Systems and Manufacturing		**23**	**$14,082,550**
	12.1	Materials	9	$5,549,502
	12.2	Structures	3	$1,799,866
	12.3	Mechanical Systems	4	$2,399,672
	12.4	Manufacturing	6	$3,748,149
	12.5	Cross-Cutting	1	$585,361
13	Ground and Launch Systems Processing		**12**	**$7,547,220**
	13.1	Technologies to Optimize the Operational Life-Cycle	1	$599,483
	13.2	Environmental and Green Technologies	3	$1,899,911

Level 1 TA	Level 2 TA		Number of Awards	Award Amount
	13.3	Technologies to Increase Reliability and Mission Availability	6	$3,847,925
	13.4	Technologies to Improve Mission Safety/Mission Risk	2	$1,199,901
14	Thermal Management Systems		**8**	**$5,048,399**
	14.1	Cryogenic Systems	2	$1,299,816
	14.2	Thermal Control Systems	6	$3,748,583
		Total	**311**	**$195,437,879**

HEOMD Investments by Technology Area

FY 2013 Phase II Awards

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
1 Launch Propulsion Systems		**2**	**$1,353,427**
	1.2 Liquid Rocket Propulsion Systems	2	$1,353,427
2 In-Space Propulsion Technologies		**4**	**$2,791,293**
	2.1 Chemical Propulsion	1	$696,448
	2.2 Non-Chemical Propulsion	2	$1,399,678
	2.4 Supporting Technologies	1	$695,167
3 Space Power and Energy Storage		**3**	**$2,084,581**
	3.1 Power Generation	3	$2,084,581
4 Robotics, Tele-Robotics and Autonomous Systems		**3**	**$2,076,164**
	4.3 Manipulation	1	$677,170
	4.4 Human-Systems Integration	1	$699,382
	4.5 Autonomy	1	$699,612
5 Communications and Navigation		**5**	**$3,495,420**
	5.1 Optical Comm. And Navigation	1	$697,498
	5.2 Radio Frequency Communications	1	$698,047
	5.4 Position, Navigation, and Timing	3	$2,099,875
6 Human Health, Life Support & Habitation Systems		**11**	**$7,697,436**
	6.1 Environmental Control Life Support & Habitation Systems	3	$2,097,962
	6.2 Extravehicular Activity Systems	2	$1,399,961
	6.3 Human Health and Performance	4	$2,799,518
	6.4 Environmental Monitoring and Safety	1	$700,000
	6.5 Radiation	1	$699,995
7 Human Exploration Destination Systems		**1**	**$697,655**
	7.1 In-Situ Resource Utilization	1	$697,655
8 Science Instruments, Observatories & Sensor Systems		**1**	**$699,747**
	8.1 Science Instruments	1	$699,747
9 Entry, Descent and Landing Systems		**1**	**$699,824**
	9.1 Aeroassist & Entry	1	$699,824
10 Nanotechnology		**2**	**$1,399,617**
	10.4 Electronics, Sensors and Devices	2	$1,399,617
13 Ground and Launch Systems Processing		**2**	**$1,399,826**
	13.2 Environmental and Green Technologies	1	$699,997
	13.3 Technologies to Increase Reliability and Mission Availability	1	$699,829
14 Thermal Management Systems		**1**	**$699,999**
	14.1 Cryogenic Systems	1	$699,999
		36	**$25,094,989**

SMD Investments by Technology Area
FY 2013 Phase II Awards

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
2 In-Space Propulsion Technologies		**1**	**$699,996**
	2.2 Non-Chemical Propulsion	1	$699,996
3 Space Power and Energy Storage		**3**	**$2,098,468**
	3.1 Power Generation	1	$699,753
	3.3 Power Management and Distribution	2	$1,398,715
5 Communications and Navigation		**1**	**$699,587**
	5.4 Position, Navigation, and Timing	1	$699,587
8 Science Instruments, Observatories & Sensor Systems		**21**	**$14,614,219**
	8.1 Science Instruments	13	$9,024,578
	8.2 Observations	1	$699,997
	8.3 Sensor Systems	7	$4,889,644
9 Entry, Descent and Landing Systems		**1**	**$691,646**
	9.3 Landing	1	$691,646
11 Modeling, Simulation, Information Technology and Processing		**2**	**$1,398,141**
	11.2 Modeling	1	$698,857
	11.4 Information Processing	1	$699,284
	Total	**29**	**$20,202,057**

ARMD Investments by Topic and Subtopic Area
FY 2013 Phase II Awards

Topic Area	Subtopic Area	Number of Awards	Award Amount
A1 Aviation Safety		**3**	**$2,099,160**
	Aviation External Hazard Sensor Technologies	1	$699,266
	Unmanned Vehicle Design for Loss-of-Control Flight Research	1	$699,962
	Verification and Validation of Flight-Critical Systems	1	$699,932
A2 Fundamental Aeronautics		**5**	**$3,462,197**
	Aero-Acoustics	1	$694,444
	Aeroelasticity	1	$699,995
	Aircraft Systems Analysis, Design and Optimization	1	$684,594
	Materials and Structures for Future Aircraft	1	$696,846
	Rotorcraft	1	$686,318
A3 Airspace Systems		**3**	**$2,099,998**
	Concepts and Technology Development (CTD)	2	$1,399,998
	Systems Analysis Integration Evaluation (SAIE)	1	$700,000
A4 Aeronautics Test Technologies		**2**	**$1,398,021**
	Ground and Flight Test Techniques and Measurement Technologies	2	$1,398,021
A5 Integrated System Research Project (ISRP)		**2**	**$1,399,516**
	Unmanned Aircraft Systems Integration into the National Airspace System Research	2	$1,399,516
	Total	**15**	**$10,458,892**

SBIR Combined Investments by Technology Area

FY 2013 Phase II Awards (HEOMD & SMD)

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
1 Launch Propulsion Systems		**2**	**$1,353,427**
	1.2 Liquid Rocket Propulsion Systems	2	$1,353,427
2 In-Space Propulsion Technologies		**4**	**$2,791,293**
	2.1 Chemical Propulsion	1	$696,448
	2.2 Non-Chemical Propulsion	2	$1,399,678
	2.4 Supporting Technologies	1	$695,167
3 Space Power and Energy Storage		**3**	**$2,084,581**
	3.1 Power Generation	3	$2,084,581
4 Robotics, Tele-Robotics and Autonomous Systems		**3**	**$2,076,164**
	4.3 Manipulation	1	$677,170
	4.4 Human-Systems Integration	1	$699,382
	4.5 Autonomy	1	$699,612
5 Communications and Navigation		**5**	**$3,495,420**
	5.1 Optical Comm. And Navigation	1	$697,498
	5.2 Radio Frequency Communications	1	$698,047
	5.4 Position, Navigation, and Timing	3	$2,099,875
6 Human Health, Life Support & Habitation Systems		**11**	**$7,697,436**
	6.1 Environmental Control Life Support & Habitation Systems	3	$2,097,962
	6.2 Extravehicular Activity Systems	2	$1,399,961
	6.3 Human Health and Performance	4	$2,799,518
	6.4 Environmental Monitoring and Safety	1	$700,000
	6.5 Radiation	1	$699,995
7 Human Exploration Destination Systems		**1**	**$697,655**
	7.1 In-Situ Resource Utilization	1	$697,655
8 Science Instruments, Observatories & Sensor Systems		**1**	**$699,747**
	8.1 Science Instruments	1	$699,747
9 Entry, Descent and Landing Systems		**1**	**$699,824**
	9.1 Aeroassist & Entry	1	$699,824

Level 1 TA	Level 2 TA	Number of Awards	Award Amount
10 Nanotechnology		**2**	**$1,399,617**
	10.4 Electronics, Sensors and Devices	2	$1,399,617
13 Ground and Launch Systems Processing		**2**	**$1,399,826**
	13.2 Environmental and Green Technologies	1	$699,997
	13.3 Technologies to Increase Reliability and Mission Availability	1	$699,829
14 Thermal Management Systems		**1**	**$699,999**
	14.1 Cryogenic Systems	1	$699,999
		36	**$25,094,989**

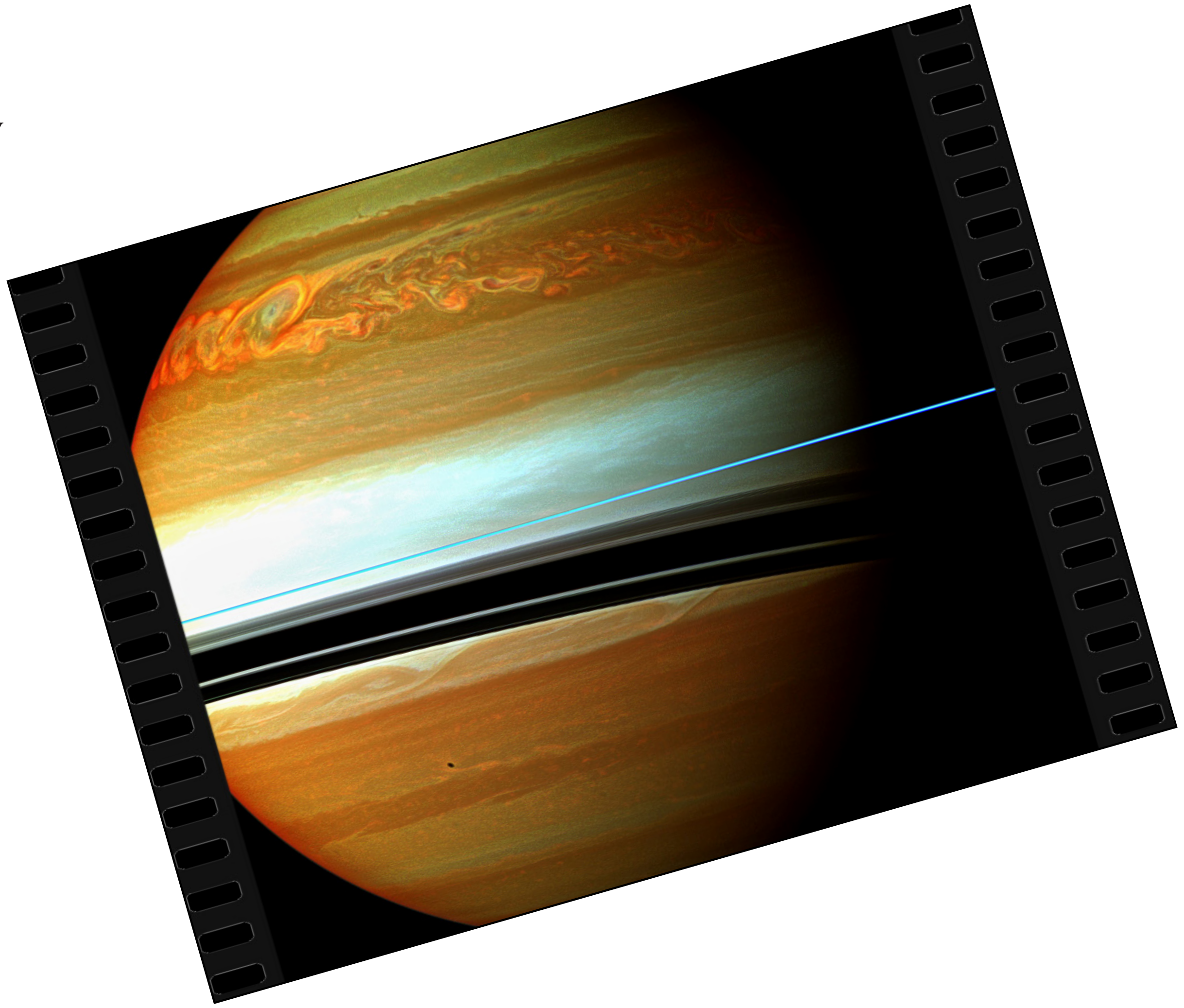
Program Executive & Management Office

Program Executive & Selection Official
Richard B. Leshner
NASA HQ / Space Technology Mission Directorate
MS 6Z22
300 E Street, SW
Washington, DC 20546
Telephone: 202-358-4920
email: Richard.B.Leshner@nasa.gov

Deputy Program Executive
Joseph Grant
NASA HQ / Space Technology Mission Directorate
MS 6X21
300 E Street, SW
Washington, DC 20546
Telephone: 202-358-0070
email: Joseph.Grant-1@nasa.gov

Program Manager
Gary C. Jahns
Ames Research Center
MS 239-11
Moffett Field, CA 94035
Telephone: 650-604-6595
email: Gary.C.Jahns@nasa.gov

Business Manager
Carlos Torrez
Ames Research Center
MS 202A-3
Moffett Field, CA 94035
Telephone: 650-604-5797
email: Carlos.Torrez@nasa.gov



Technology Manager
Luis Mederos
Ames Research Center
MS 202A-3
Moffett Field, CA 94035
Telephone: 650-604-5268
email: Luis.Mederos@nasa.gov

Technology Infusion Manager
Ryszard (Rich) Pisarski
Ames Research Center
MS 202A-3
Moffett Field, CA 94035
Telephone: 650-604-0149
email: Ryszard.L.Pisarski@nasa.gov

Procurement
Cassandra Williams
NASA Shared Services Center
Bldg 5100/202-125
Stennis Space Center, MS 39529
Telephone: 228-813-6271
email: Cassandra.Williams@nasa.gov

www.sbir.nasa.gov

December 2013
NP-2013-12-01-ARC